

WHAT IS CLAIMED IS:

1. An electro spinning process for extruding a thread-forming polymer and drawing between an electrically charged die, having a first electrical bias and a first polarity and an electrically charged collecting means to produce a continuous polymer filament, comprising the steps of:

liquefying the thread-forming polymer and extruding through a die orifice to form a liquid-state filament,

drawing the liquid-state filament through a longitudinally sequentially biased electrostatic field having the same polarity as the first polarity, thereby imparting a bias gradient to the liquid-state filament,

solidifying the liquid-state filament to form a linearly oriented solid polymer filament, and

collecting the solid polymer filament on the collecting means.

2. The electro spinning process of Claim 1 wherein the die and electrostatic field are positively biased and the collecting means is negatively biased.

3. The electro spinning process of Claim 1 wherein the die and charged electrostatic field are positively biased and the collecting means is grounded.

4. The electro spinning process of Claim 1 wherein the longitudinally sequentially biased field gradient has a length of 3 centimeters or more.
5. The electro spinning process of Claim 1 wherein the longitudinally sequentially biased field gradient has a length of 3 to 100 centimeters.
6. The electro spinning process of Claim 1 wherein the longitudinally sequentially biased field gradient is linearly charged.
7. The electro spinning process of Claim 1 wherein the longitudinally sequentially biased field gradient is linearly charged to 10,000 to 300,000 volts/meter.
8. The electro spinning process of Claim 1 wherein the longitudinally sequentially biased field gradient is linearly charged to 50,000 to 250,000 volts/meter.
9. The method of Claim 1 wherein the polymer filament is extruded to a diameter of 100 to 500 nanometers.
10. An electro spinning apparatus for producing a continuous polymer filament, fiber and the like from a thread-forming polymer, which comprises:

- a. an electrically conductive liquid polymer extrusion die having at least one die orifice,
- b. an electrically conductive filament collection means spaced from the die orifice,
- c. an electrode means positioned between the die orifice and the filament collection means, the electrode means comprising n chargeable electrodes, wherein n is an integer of from 1 to 50,
- d. means for providing a first electrical bias to the die and an $(n+2)^{\text{th}}$ electrical bias to filament collection means,
- e. means for providing a second electrical bias to the electrode means, said second electrical bias having the same polarity and a magnitude equal to or less than that of the first electrical bias.

11. The electro spinning apparatus of Claim 10 wherein the electrode means comprises a plurality of electrodes.

12. The electro spinning apparatus of Claim 10 wherein the electrode means comprises a plurality of longitudinally spaced electrodes.

13. The electro spinning apparatus of Claim 10 wherein the electrode means comprises a plurality of 3 to 50 uniformly spaced electrodes.

14. The electro spinning apparatus of Claim 10 wherein the electrode means comprises a plurality of electrodes, biased to provide a linear field gradient between the die and the filament collection means.

15. The electro spinning apparatus of Claim 10 wherein the electrode means comprises 1 to 20 electrodes, sequentially biased to provide a linear field gradient between the die and the filament collection means.

16. The electro spinning apparatus of Claim 10 wherein the electrically conductive filament collection means is spaced at least about 3 centimeters from the die orifice.

17. The electro spinning apparatus of Claim 10 wherein the first and second electrical biases are positive.

18. The electro spinning apparatus of Claim 10 wherein the first and second electrical biases are positive and the $(n+2)^{th}$ electrical charge is ground.

19. The electro spinning apparatus of Claim 10 wherein n is an integer of from 3 to 20.

20. The electro spinning apparatus of Claim 10 wherein n is an integer of from 5 to 10.

21. The electro spinning apparatus of Claim 10 wherein the chargeable electrodes are independently biased.